Developing and Implementing an Energy Savings Program at UPSOM

Project Title: Energy Audit and Pre-Feasibility Study for Energy Efficiency Improvement
Leader: BEGA UPSOM, SA
Partners: Sustainable Energy Partnerships, US and EnergoBit SRL, Romania
Location: Ocna Mures, Romania
Project Duration: January – October, 2002
EcoLinks Project Investment: Total Project Investment: $ 69,330; EcoLinks Grant Support: $ 48,970 ; Project Team Cost Share Contribution: $ 20,360

Best Practice: Transferable Solution

This project is a best practice because it demonstrated how monitoring and managing energy flows at a large industrial complex generate notable cost savings and significantly reduce harmful emissions. In addition to the methodology and approach to improving energy efficiency, many of the specific findings and recommended solutions generated through this project are applicable to other large industrial manufacturing companies that also generate heat and electricity for their own purposes. A particularly effective and highly transferable approach to making energy and cost saving improvements was prioritizing the implementation of low and medium cost measures first, and then acting on higher cost measures. Simple "good practice" measures such as changing tariff structures, for example, maximized savings with minimal investment.

Project Summary

UPSOM, a leading soda ash manufacturer in Romania, was established in 1894 by "Solvay & CO" from Belgium and "Vereinsfurchemisce und Metalurgische Produktion" from Germany. The plant's main product is soda ash which constitutes approximately 85% of the company's total production. Soda ash is used to manufacture multiple products including chemicals, pharmaceuticals, metals, glass, pulp and paper, cosmetics, and textiles.

Soda ash production is energy intensive. UPSOM consumes a great deal of energy, and energy efficiency is critical to its environmental performance and competitive status. UPSOM gets its energy from its own combined heat and power station and the power grid. The combined heat and power station includes: three steam boilers, a feed water treatment station, two pressure reduction stations and pumps. Two Lang-type steam boilers were commissioned in 1957 and a third one (CR 12) in 1970. Electricity is produced by steam in an 8.2 MW Lang turbine that was commissioned in 1957. In order to completely cover its electricity demand, the company also buys approximately 18% of it from the power grid.

The company consumes approximately 47,000 MWh of electricity, and 82 million m^3 of gas per year. UPSOM's energy costs in 2001 were approximately $8.2 million, representing 60% of the total production costs. The production of soda ash is the biggest consumer of steam (64%) and electricity (53%). The heat and power station that produces steam and electricity consumes most of the natural gas (71%). The company emits approximately 7,200 kg of CO, 720,000 kg of NO_x, and 548,000 kg of CO_2 per year.

With the support of an EcoLinks Challenge Grant, UPSOM collaborated with Sustainable Energy Partnerships, a US firm, and Energobit, a local Romanian partner, to develop an energy savings program. The program included the introduction of a modern power monitoring system and a financial analysis detailing low, medium, and high cost energy saving opportunities. The financial analysis also included an estimate of the company's financial capacity for making investments in energy efficiency measures.

The project team investigated in detail the heat and electricity generation and consumption at UPSOM. They recommended several low and medium cost measures requiring a total investment outlay of $872,000 with an annual cost savings of $906,000, representing a very good rate of return (IRR). The simple payback period varied between 0.3 and 1.2 years. Two very attractive high cost investment strategies totaling $3.63 million with an IRR of 15% that would ultimately produce a savings of $671,700 per year were developed and recommended.

In addition to these cost savings, environmental benefits were also generated. Implementation of the improvement measures can reduce the total emissions by 28%. A change in the electricity tariff structure, one of the recommended low-cost, short-term improvement measures, was implemented within a month after the project was completed. The experience and information generated from the project were shared by team members and presented in a two-day seminar for several companies including those from the Bega Group (an investment group of 31 companies).

Project Activities

1. Conducted an electricity and heat generation and consumption assessment.

An energy assessment strategy was developed and implemented over a period of three months. It included on-site measurements as well as an analysis of historical energy consumption using company records. Measurements of the flow of reactive energy from transformer substations and other big power consumers such as pumps and CO_2 compressors were taken. The data were used to design software for an energy monitoring system and also to establish ongoing monitoring sites of key energy consumers.

Products: Data on steam and electricity generation and consumption

2. Installed a monitoring system.

Given the importance of electricity consumption at UPSOM, a ten-point electricity monitoring system of the major power consumers was installed. This system may also be developed and applied to monitor other electricity points and also the flow, temperature and pressure of other non-electric energy sources including natural gas, exhaust fumes, and water.

The ten-point electricity monitoring system included ten modern energy meters that record active and reactive power, electricity flow to and from the grid, and the power factor (the ratio between apparent and active power). Meters were installed in the transformer stations, the electric generator, the big power consumers like the soda ash workshop, the pump stations, the CO_2 compressors and the heat and power station. The data collected by these meters were continuously monitored through the company's computer network, and processed in reports on consumption patterns over time.

The measurement equipment was purchased with cost share support from the local partner, EnergoBit. The computer and the customized software was purchased with Ecolinks funds. Another 15 locations for electric measurements were also identified. UPSOM expressed its commitment to install a monitoring system for these locations in the near future.

Product(s): 1) A ten-point monitoring system for on-site electricity generation and consumption 2) Commitment to installing monitoring system in 15 other locations

3. Conducted an energy audit.

A detailed energy audit of the heat and power station, the pump station, the CO_2 compressor station and soda ash production was performed. The audit revealed where the most significant energy losses occur, and hence where improvements were needed. Some of the main findings of the audit were:

1. The steam boilers, being very old (approximately 50 years), operate at a 61% rate of efficiency compared to modern gas fired boilers that operate at 85 – 90% efficiency. Most of the energy (23.5%) is lost as heat, due mainly to inefficient gas combustion and a poorly automated boiler control system. Moreover, the steam boilers operate at a low load of 60 –70%, also a contributing factor to their low efficiency.
2. The boilers are not monitored. A significant portion of the consumption of steam, gas and water, for example, is not measured. Hence, heat production rarely meets heat demand.
3. The steam pipe insulation is old and poor leading to heat loss through the pipe network. Most of the steam pipes are lacking steam traps. Where steam traps do exist, they are not operating properly and a lot of heat (5% of the input) is lost through condensation. Defective steam valves in the steam-pressure reduction stations contribute to further heat loss.
4. Space heating and sanitary water consumption are higher than necessary due to a lack of monitoring meters and control mechanisms.
5. At least 10% of the energy loss in the steam system is due to inefficient use of the de-aerators' capacity and lack of pre-heating and recovery processes.
6. The steam turbine and the Lang electricity generator are very old and operate at 55 % of their nominal load leading to heat losses of around 8 % of the heat input.
7. Due to the low power factor associated with UPSOM's electric generator (0. 66). UPSOM incurs unnecessarily high penalties from the power grid company.
8. The pump station operates at a lower power factor (0.8) than the neutral value of 0.92 recommended by the grid company, hence more penalties from the latter.
9. In addition to two CO_2 steam compressors, UPSOM uses one electric compressor that is very costly to operate and maintain.

Product(s): Energy audit report

4. Prepared a pre-feasibility study.

Based on the findings of the energy audit, the project team conducted a pre-feasibility study to reduce energy use and related greenhouse gas emissions. A number of low and medium cost measures as well as high cost measures were identified. A financial analysis was also conducted and included estimates of the internal rate of return (IRR), net present value (NPV) and the return on investment ratio (SIR) for each of the proposed measures. These calculations are summarized in Table 1. Financial analysis of improvement measures.

Recommended improvement	Investment ($)	Estimated cost savings ($/year)	Net Present Value ($)
A. Low and Medium Cost Measures			
Installation of gas meters	33,500	48,000	237,213
Installation of water and steam meters	66,000	97,000	481,247
Installation of an energy management center	23,000	22,500	103,881
Insulation of steam pipelines	10,500	12,200	58,822
Installation of inverted bucket steam traps	38,400	112,700	598,155
Installation of steam water heat exchanger for sanitary water preparation	21,000	6,000	13,787
Installation of plate heat exchangers for space heating	230,000	170,000	737,025
Recovery of condensation in the CHP plant	42,600	98,000	510,088
Installation of an electric four channel meter adder	3,600	30,000	164,777
Installation of condensers to compensate for the poor power factor at the electric generator	92,100	147,000	740,184
Modernization of CO_2 compressors	312,000	163,000	616,386
B. High Cost Measures			
Replacement of two steam (Lang) boilers with new ones	1,080,200	202,500	106,108
Replacement of the old steam turbine with a new 6 MW steam turbine	2,548,000	469,200	220,181

Product(s): Financial analysis of all the recommended measures

5. Disseminated the results.

The project team presented the results of the project to Bega Group's managers, UPSOM staff and management and other similar company representatives in a two-day workshop. As a result, Bega Group Managers (representing 31 companies) decided to apply the same analysis in other companies.

Product(s): Two-day workshop

Project Benefits

There are several benefits generated by this project. They include capacity building, through very good teamwork and outreach, and notable economic and environmental benefits including cost savings and reductions in greenhouse gas emissions through improved energy efficiency.

Capacity Building Benefits

The local and cross border partners who collaborated on this EcoLinks project learned from each other and shared their skill and expertise in promoting energy efficiency with the UPSOM team staff and managers. Many of the measurement efforts and experiments with the monitoring software were conducted jointly by the local partner and the team leader to generate an effective monitoring system which provides a model for other similar sites.

As the project generated more information on the benefits of some of the low cost measures, the team leader was able to take this information and immediately start work on implementing these measures. For example, changes were made to the electricity tariff policy. Upon investigating the current tariff structure it was discovered that a savings of approximately $30,000 per year could be achieved by: 1) installing a special meter (valued at $3,600), and 2) requesting the grid company to enroll the company in another, more cost effective tariff category.

UPSOM employees learned how to design and implement an effective monitoring system and use the results. The local partner trained the UPSOM project team in electricity consumption monitoring of ten key consumers once the new program and system were installed. UPSOM project participants recognized the opportunity for cost savings and decided to implement the system in another 10 – 15 large utility consumers at the facility.

Environmental Benefits

The environmental benefits derived by the project are reduced greenhouse gas emissions. Gas consumption is reduced by approximately 16.3 million m^3 per year with implementation of the recommended improvement measures. Emissions reductions would be as follows: NO_x emissions by 206 tons/year and CO_2 emissions by 156 tons/year. These reductions represent approximately 28% of the total current emissions.

Economic Benefits

Many economic benefits are generated with the implementation of the proposed improvement measures. Heat savings, and subsequently natural gas savings, are generated from: 1) installing steam traps and recovering heat loss from condensation; 2) installing condensers to compensate for the poor power factor and thereby avoiding high penalties charged by the electric grid company; 3) replacing the electric CO_2 compressor with a new steam driven one; 4) installing meters and monitoring gas, water, and steam consumption at key consumer sites; and 5) by automating the operation of the steam boilers.

The total low and medium cost investments add up at $872,000 generating a cost savings of $906,000 comprising a very good return on investment ratio. The simple payback period varies between 0.3 and 1.2 years. Large cost investments total $3.63 million and could save as much as $671,700/year. These are also attractive investments since they have an IRR of 15 %.

Lessons Learned

- Planning in advance for unexpected technical delays due to the age of the technology is very important and should be considered. The project team cooperated very successfully during the entire time of the project. Some delays occurred, however, when the monitoring system was installed. The delay was mainly due to the unexpected poor state of the available, on-site measurement cells. Many measurements had to be double-checked. A new solution was adopted to prevent errors in the measurement of key parameters used later to design the monitoring software.

- Constant involvement of the UPSOM team members and management throughout the lifetime of the project was crucial, especially for making timely decisions in the case of demonstration projects.

- Continuous communication between partners and agreement on solutions before implementation saves time and money.

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